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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/735,122

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Grant Kloster

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EXAMINER

TSOY, ELENA

ART UNIT

PAPER NUMBER

1792

MAIL DATE

DELIVERY MODE

07/23/2008

PAPER

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

<b>Office Action Summary</b>	<b>Application No.</b> 10/735,122	<b>Applicant(s)</b> KLOSTER ET AL.	
	<b>Examiner</b> Elena Tsoy Lightfoot	<b>Art Unit</b> 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 16 June 2008.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1, 12-17, 25 and 27-31 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1, 12-17, 25 and 27-31 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 12 December 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |                                                                                                                        |                                                                                         |
|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                                            | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____                                                |

***Continued Examination Under 37 CFR 1.114***

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/16/2008 has been entered.

***Response to Amendment***

Amendment filed on June 6, 2008 has been entered. Claims 1, 12-17, 25, 27-31 are pending in the application.

***Claim Objections***

1. Objection to claim 1 because of the informalities has been withdrawn due to amendment.
2. Claim 12 is objected to because of the following informalities: Claim 12 recites “a thiol end cap” in line 3 and “the thiol endcap” in line 7. Appropriate correction is required.
3. Claim 13 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 13 recites “wherein the silane coupling agent comprises a silicon atom, and wherein the thiol end cap is coupled to the silicon atom” which was recited already by claim 12. Therefore, claim 13 should be rewritten in a proper dependent form, for example, as “wherein the flexible chain comprises a substantially long chain of CH<sub>2</sub> groups”.

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4. Claim 14 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim 13. Claim 14 should be rewritten in a proper dependent form, for example, as “wherein the substantially long chain of CH<sub>2</sub> groups comprises at least 4 CH<sub>2</sub> groups”.

5. Claim 15 is objected to because of the following informalities: Claim 15 recites “OCH<sub>3</sub>, O-ethyl, O-methyl”. However, OCH<sub>3</sub> is O-methyl. Therefore, “OCH<sub>3</sub>, O-ethyl, O-methyl” should be changed to “~~OCH<sub>3</sub>~~, O-ethyl, O-methyl”. Appropriate correction is required.

6. Claim 16 is objected to because of the following informalities: “OCH<sub>3</sub>” should be changed to “O-methyl” since claim 15 recites alkoxy side groups in the form of “O-alkyl”. Appropriate correction is required.

7. Claim 30 is objected to because of the following informalities: “OCH<sub>3</sub>” should be changed to “O-methyl” since claim 15 recites alkoxy side groups in the form of “O-alkyl”. Appropriate correction is required.

***Claim Rejections - 35 USC § 112***

8. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

9. Rejection of claim 1 under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement has been withdrawn due to amendment.

10. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

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11. Rejection of claims 27-30 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention has been withdrawn due to amendment.

12. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 recites a limitation “wherein the coupling agent reacts with the porous dielectric material to form coupling structures linked to the dielectric material”, which is confusing because it is not clear whether the coupling agent reacts with reactive groups adjacent a surface of the porous material or to the surface itself. For examining purposes the limitation was interpreted according to the Applicants’ specification (See Published Application, P19) as “wherein the coupling agent *reacts with the reactive groups* adjacent the surface of the porous dielectric material to form coupling structures linked to the dielectric material”.

13. Claims 12-17 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps **essential for sealing** a pore are:

(i) "reacting the at least one alkoxy groups of the coupling agent with SiOH groups at the surface of the pore to form coupling structures linked to the pore; introducing an oxidizing agent ...". Without introducing this step *after* the step of introducing a silane coupling agent, it is not clear whether the bridge structure (disposed across the opening of the pore) is linked to the pore or not;

(ii) “introducing an oxidizing agent to facilitate formation of disulfide bonds” should be changed to “introducing an oxidizing agent to form ~~facilitate formation of~~ disulfide bonds” because it is not clear whether disulfide bonds are formed or not.

14. Claims 25, 27-31 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 25 recites “exposing the exposed pore to a coupling agent; forming links coupling the coupling agent to a surface of the pore; exposing the exposed pore and the coupling agent to an oxidizing agent; and forming a barrier across the pore”, which is confusing because it is not clear whether non-linked exposed pore and the coupling agent are exposed to the oxidizing agent” or the coupling agent that is linked to the surface is exposed to the oxidizing agent. For examining purposes the phrase was interpreted as “exposing the exposed pore to a coupling agent; forming links coupling the coupling agent to a surface of the pore; exposing ~~the exposed pore and~~ the coupling agent linked to the surface of the pore to an oxidizing agent; ~~and~~ thereby forming a barrier across the pore”.

Claim 25 recites “wherein the barrier comprises a barrier molecule comprising a silicon atom coupled to a surface of the pore, a sulfur atom, and a flexible chain between the silicon atom and the sulfur atom, wherein the flexible chain comprises a portion of a bridge structure that is capable of sealing the pore, and wherein the bridge structure is disposed across the opening of the exposed pore”, which renders the claim indefinite because “a molecule comprising a silicon atom coupled to a surface of the pore, a sulfur atom, and a flexible chain between the silicon atom and the sulfur atom” is not a *barrier molecule* but a molecule of the coupling agent.

It is not clear whether a barrier in claim 25 is made from two molecules of the coupling agents linked to surface of the pore or from two barrier molecules as recited in claim 27. Note that claim 27 recites that the barrier across the pore in claim 25 is formed *two barrier* molecules. Thus, how a barrier molecule and coupling agent molecule in claim 25 correspond to each other.

15. Claims 25, 27-31 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps **essential for sealing** a pore are: forming disulfide bonds between *coupling agents* (not barrier molecules) that are ***linked*** to the surface of the pore.

### ***Claim Rejections - 35 USC § 103***

16. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

17. Claims 12-16, 25, 27-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ivanov et al (US 6,881,437) in view of Ogawa et al (US 5,103,371), further in view of Ogawa et al (US 4,673,474) and Ogawa et al (US 5,466,523), further in view of Ogawa et al (US 20010031364), and further in view of Fleckenstein et al.

Ivanov et al disclose a method of ***sealing*** a *porous* dielectric layer 144 (See column 46, lines 25-26) adjacent a substrate layer 142 (See column 38, lines 48-60) with a hydrophobic dielectric 156 (See column 46, lines 20-21), the method comprising depositing *any* silane material having silane functional groups such as alkyltrichlorosilanes or alkenyltrichlorosilanes

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(claimed coupling agent) (See column 46, lines 37-48) to the porous layer, e.g. SiO<sub>2</sub> layer (known to have reactive SiOH groups on the surface) (See column 38, line 60) to **absorb** the silane material within the dielectric material 144 (See column 46, lines 56-57); exposing the silane material *absorbed* within dielectric layer 144 to deionized water (claimed crosslinking sealing agent) after the deposition of the silane material to hydrolyze and remove any hydrochloric acid such that a **strong bond** between hydrophobic 156 and dielectric layer 144 may be formed (i.e. the silane material reacts with the porous dielectric SiO<sub>2</sub> layer) (See column 46, lines 51-59) for **preventing moisture** and components of an electroless deposition solution into a low-k dielectric layer 144 (See column 46, lines 26-30).

It is the Examiner's position that the *chemical absorption* of the silane followed by hydrolysis provides *impermeability to moisture* in Ivanov et al by reacting Si-Cl groups of the chorosilane with Si-OH groups on the surface of the porous SiO<sub>2</sub> layer thereby forming coupling structures linked to the porous dielectric layer, and by reacting adjacent silane molecules thereby forming a silicone *polymer* as a barrier to moisture, as evidenced by Ogawa et al '371 (See Fig. 2; column 2, lines 18-22, 51-68; column 5, lines 14-18). Ogawa et al '371 teaches that by forming a monomolecular film 4 by *chemical absorption* techniques provides *excellent moisture resistance* through strong siloxane bonds between silane molecules and between the film and the surface (See Fig. 2; column 5, lines 14-18).

Ivanov et al in view of Ogawa et al '371 fails to teach that HS-(CH<sub>2</sub>)<sub>n</sub>-SiCl<sub>3</sub> may be used as silane coupling agent.

Ogawa et al '474 teaches that a chemical reagent having reactive group at one end and having another reactive group at the other end may be used for forming a molecular film on e.g. SiO<sub>2</sub> substrate (See column 2, lines 65-68) by an *absorption* technique (See column 2, lines 20-



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29). The chemical reagent may include Si and a vinyl group (See column 2, lines 30-31) such as  $\text{CH}_2=\text{CH}-(\text{CH}_2)_n-\text{SiCl}_3$  ( $n = 10-20$ ) (See column 3, lines 1-23). The reagent may also include  $-\text{NH}_2$ ,  $-\text{SH}$  or acetylene groups (See column 2, lines 30-33). Ogawa et al '474 does not expressly teach that  $\text{HS}-(\text{CH}_2)_n-\text{SiCl}_3$  may be used as the chemical reagent. However, Ogawa et al '523 teaches that  $\text{HS}-(\text{CH}_2)_n-\text{SiCl}_3$  may be used as a chemical reagent for forming a molecular film by an *absorption* technique (See Figs. 9(c), 15(c)). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have used  $\text{HS}-(\text{CH}_2)_n-\text{SiCl}_3$  as a chemical reagent of Ogawa et al '474 having Si and SH reactive groups.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used  $\text{HS}-(\text{CH}_2)_n-\text{SiCl}_3$  as a silane coupling agent in Ivanov et al in view of Ogawa et al '371 instead of vinyl containing silane coupling agent with the expectation of providing the desired pore sealing since Ivanov et al teaches that *any* silane may be used for chemical absorption, and Ogawa et al '474 and Ogawa et al '523 teach that  $\text{HS}-(\text{CH}_2)_n-\text{SiCl}_3$  is suitable for chemical absorption. It is held that the selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945). See MPEP 2144.07.

Ivanov et al in view of Ogawa et al '371, further in view of Ogawa et al '474 and Ogawa et al '523 fails to teach that  $\text{HS}-(\text{CH}_2)_n-\text{SiOR}_3$  (Claim 12) may be used instead of  $\text{HS}-(\text{CH}_2)_n-\text{SiCl}_3$ ; the flexible chain comprises a substantially long chain of  $\text{CH}_2$  molecules (Claim 20) such as 4 chains (Claim 21).

Ogawa et al '364 teaches that in a chemical absorption technique for forming a polysiloxane film on OH containing substrate (See P84), the use of alkoxysilane compounds makes it possible to control the progress of the reaction with water or the progress of the

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polymerization by temperature, and in contrast to chlorosilane compounds, alkoxysilane compounds do not produce harmful side products such as hydrochloric acid (See P80-82, 85, 86). When the solution of a chlorosilane compound is used, the OH groups on the substrate surface and the chlorosilyl groups cause *dehydrochlorination*, and thereby the chlorosilane compound is bonded with the substrate surface by siloxane bonds. By contrast, when the solution for forming a silica-based coating film contains an alkoxysilane compound, the OH groups on the substrate surface react with Si—OR causing the desorption of R—OH, and the alkoxysilane compound is bonded with the substrate surface by siloxane bonds (See 83).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used alkoxy groups instead of Cl groups in an absorbing silane of the above cited prior art, i.e. have used HS-(CH<sub>2</sub>)<sub>n</sub>-SiOR<sub>3</sub> instead of HS-(CH<sub>2</sub>)<sub>n</sub>-SiCl<sub>3</sub>, with the expectation of providing the desired control of the progress of the reaction with water without producing harmful hydrochloric acid, as taught by Ogawa et al '364.

The cited prior art fails to teach that SH groups are crosslinked.

Ogawa et al '371 further teaches that it is possible to further strengthen and stabilize the monomolecular film 4 by *crosslinking* (indicated by 6 in FIG. 3) functional groups, e.g. **vinyl** groups (CH<sub>2</sub>=CH--) in the silicone polymer chains (See column 3, lines 5-8).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have further crosslinked absorbed SH end groups in an absorbed silane of the cited prior art with the expectation of further strengthening and stabilizing the absorbed film, as taught by Ogawa et al '371.

The cited prior art fails to teach that SH groups are crosslinked by introducing an oxidizing agent to form disulfide bonds between adjacent oxidized thiol end groups.

However, it is well known in pore sealing art to attach thiol group-containing compounds to pores, then subject the attached thiol group-containing compounds to oxidative crosslinking, accompanied by the formation of disulphide bridges, as evidenced by Fleckenstein et al (See column 1, lines 42-47).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have subjected thiol group-containing compounds attached to pores in the cited prior art to known oxidative crosslinking with the expectation of providing the desired further strengthening and stabilizing the absorbed film.

18. Claims 17 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over cited prior art above, and further in view of Cottle et al (US 2,874,192).

The cited prior art fails to teach that the oxidizing agent comprises formaldehyde.

However, it is well known in the art that disulfides such as mercaptals can be formed by reacting mercaptans with aldehyde, as evidenced by Cottle et al (See column 1, lines 3-8).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used aldehyde including formaldehyde as oxidizing agent in the cited prior art with the expectation of providing the desired oxidative crosslinking by forming disulfides since it is well known in the art that disulfides can be formed by reacting mercaptans with aldehyde, as evidenced by Cottle et al.

19. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Kajiura et al (US 5907382) is cited to show that silanes having hydrolysable alkoxy side groups such as vinyl silane, amino silane and acrylic silane, e.g.

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methacryloxypropyltrimethoxysilane (See column 7, lines 52-60) are suitable for **sealing** (See column 16, lines 58-59) a *porous* dielectric layer (See column 7, lines 49-51).

***Response to Arguments***

20. Applicant's arguments with respect to claims 1, 12-17, 25, 27-31 have been considered but are moot in view of the new ground(s) of rejection.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Elena Tsoy Lightfoot whose telephone number is 571-272-1429. The examiner can normally be reached on Monday-Friday, 9:00AM - 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on 571-272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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Art Unit 1792

July 23, 2008

/Elena Tsoy Lightfoot/

Primary Examiner, Art Unit 1792